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# Management of Fusarium wilt in banana under coastal Odisha conditions

**Y PUSHPAVATHI, SN DASH, MK MISHRA and V TRIVENI**

**College of Agriculture, Orissa University of Agriculture and Technology Bhubaneswar 751003 Odisha, India**
Email for correspondence: satya1962@yahoo.co.in

## ABSTRACT

In Odisha the popular culinary banana variety Bantal suffers much from Fusarium wilt disease limiting its cultivation. An integrated effort has been made in the present experiment for effective management of the disease through a combination of chemicals, biocontrol agents and botanicals. The experiment was conducted at the Horticultural Research Station, Orissa University of Agriculture and Technology during 2013-14 in complete randomized block design. Ten treatments comprising of various combinations of chemicals, biocontrol agents and botanicals were replicated three times. The soil of the experimental plot was medium in available nitrogen, low in both available phosphorus and potash, sandy loam textured with a pH of 5.3. Sucker treatment and soil drenching with biocontrol agents *Trichoderma viride* and *Pseudomonas fluorescens* produced maximum pseudostem height (147.40 cm), pseudostem girth (45.67 cm), total number (11.67) and area (4.61 $cm^2$) of leaves and minimum percentage of yellow (23.50) and dead leaves (31.00) in a plant. Due to better control of disease incidence this treatment also resulted in minimum flowering time (262 days) and maximum bunch yield (10.31 kg/plant). Soil application of the biocontrol agents *T viride* and *P fluorescens* was also effective in controlling the disease.

**Keywords:** Banana; Fusarium wilt; biocontrol agents; yield

## INTRODUCTION

Bananas and plantains the major staple food crops for millions of people in the developing countries of tropics are grown in more than 130 countries across the world in an area of 5.14 million hectares producing 105.32 MT of banana and plantain (Anon 2013a). India is the largest producer of banana in the world producing 26.50 MT (Anon 2013b). However the production and productivity of banana is confronted with various biotic and abiotic stress factors which vary from region to region. Fusarium wilt caused by the fungus *Fusarium oxysporum* f sp *cubense* (Foc) has been recognised as one of the most widespread and destructive plant diseases in the recorded history of agriculture (Simmonds 1966). In India Fusarium wilt susceptible varieties roughly

occupy one fourth of the total area under banana where yield losses may go up to 90 per cent by the incidence of the disease (Thangavelu et al 1999). In Odisha a coastal state of India 70 per cent of the soil is acidic in nature which increases the occurrence of panama wilt disease limiting the cultivation of banana. The culinary varieties have demand in the coastal regions but are very much susceptible to this disease.

Integrated management programme for Fusarium wilt could combine disease tolerance with strategies such as chemical, biological and cultural control. Since the options for the control of the disease are limited, disease management is possible only by integrating different effective strategies like growing resistant cultivars and adopting proper cultural, chemical and biological measures. Biological control of Fusarium wilt is an important disease management option in view of the novel mechanisms of plant protection associated with certain microorganisms (Weller et al 2002, Fravel et al 2003).

The present study was undertaken to evolve an integrated approach involving chemicals, botanical, and biocontrol agents for the management of Fusarium wilt disease in banana.

## MATERIAL and METHODS

The investigations were carried out at the Horticultural Research Station, Orissa University of Agriculture and Technology during 2013-14. The station is located at a latitude of 20° 152 N and longitude of 85° 522 E. It is about 60 km away from Bay of Bengal and has an altitude of 25.5 m amsl. The composite test soil sample was sandy loam in texture with a pH of 5.3. It was medium in available nitrogen (268.2 kg/ha) and low in both available phosphorus (10.4 kg/ha) and potash (94.0 kg/ha).

The experiment was laid out in complete randomized block design. Ten treatments were replicated thrice. Five banana plants were accommodated in each treatment. A uniform inter- and intra-row spacing of 2.2 x 2.2 m was adopted between the plants. The treatments applied both as soil application and soil drenching were $T_1$ (sucker dip treatment with carbendazim 50 WP 0.2% + Blitox 50 WP 0.3% + bleaching powder 0.015% for 30 min), $T_2$ (sucker dip treatment with Captan 50 WP 0.3% + Vitavax power 75 WP 0.5% + bleaching powder 0.015% for 30 min), $T_3$ (sucker dip treatment with *Trichoderma viride* + *Pseudomonas fluorescens* 20 g/l for 30 min), $T_4$ ($T_1$ + soil drenching with $T_1$ chemicals at 30 and 180 DAP), $T_5$ ($T_2$ + soil drenching with $T_2$ chemicals at 30 and 180 DAP), $T_6$ ($T_3$ + soil drenching with *T viride* + *P fluorescens* at 30 and 180 DAP), $T_7$ ($T_4$ + soil drenching with $T_2$ chemicals alternatively at 30 and 180 DAP), $T_8$ (soil application with *T viride* + *P fluorescens* at 30 and 180 DAP), $T_9$ (neem cake application 250 kg/ha at

planting and 180 DAP) and $T_{10}$ (control).

Prior to the start of the experiment the plot was grown with a uniform crop of cowpea to have the effect of a uniformity trial during summer 2013. One month old banana suckers of the test culinary variety Bantal of uniform size were collected from severely Fusarium wilt infected banana fields. Planting of treated suckers was done in the third week of June 2013. The recommended doses of fertilizers were applied to each plant @ 200:50:200 g N, $P_2O_5$ and $K_2O$ along with 20 kg of well rotten FYM. All the plant protection measures were adopted as per need except that for Fusarium wilt to raise an otherwise healthy crop.

For dip treatment the selected suckers of banana were dipped in different fungicidal and biocontrol solutions for 30 minutes and dried in shade. For soil application of biocontrol agents 200 g of fresh stock of each *T viride* and *P fluorescens* were mixed separately with 20 kg of well rotten and powdered FYM with addition of sufficient quantity of water. These mixtures were covered with polyethylene sheet for two days. Every day the mixtures were stirred thoroughly by sprinkling water to maintain the moisture content around 30 per cent up to 21 days for better growth of biocontrol organisms. After this period of incubation the mixtures were applied to the base of the banana plants evenly @ 10 quintals/ha one month after planting and was repeated after six months around which the disease symptoms appeared in most of the plants. Similarly neem cake was used as soil application in $T_{9.}$ Well powdered neem cake was applied at the base of the plants evenly @ 250 kg/ha at the time of planting and repeated six months after.

Soil drenching of chemicals was carried out around the base of the plants twice ie two and six months after planting. To ensure the full incidence of wilt disease in the test plants chopped, rhizomes and some soil from around heavily wilt infected plants were applied to the base two months after planting. Samples were analysed in laboratory for confirmation of the disease incidence.

Observations on growth characters like pseudostem height, pseudostem girth, number of leaves per plant and area of leaf and yield related characters such as days taken to shooting and bunch yield were recorded at different time intervals. Similarly disease characters viz number of yellow and dead leaves caused by Fusarium wilt were also observed. The data recorded in five plants in each treatment and replication in respect of growth, disease and yield parameters were subjected to statistical analysis for test of significance following the procedure outlined by Panse and Sukhatme (1985).

## RESULTS and DISCUSSION

### Growth characters (Table 1)

**Plant height:** The results indicate significant variations in plant height during the final stage of observation ie 270 DAP. The height ranged from a minimum of 106 cm in $T_{10}$ to a maximum of 147 cm in $T_6$. The maximum value showed an increase of 38.7 per cent in plant height over the control.

**Plant girth:** The treatments had significant effect on the pseudostem girth at the final stage of plant growth (270 DAP). The lowest plant girth of 35.17 cm was recorded in $T_{10}$ whereas the highest value of 45.67 cm was achieved in $T_6$. However $T_8$ with soil application of biocontrol agents resulted in at par value of 44.17 cm indicating the beneficial effect of the microorganisms. Such findings are confirmed by Thangavelu and Mustaffa (2010).

**Number of leaves:** The number of leaves produced in a plant varied from 8.27 in $T_{10}$ to 11.7 in $T_6$ at 270 DAP. The results significantly differed at the later three stages though it was not so at 90 DAP. While the number of leaves per plant increased gradually at 90, 150 and 210 DAP they decreased at 270 DAP ie towards the time of shooting. The reduction in the number of leaves towards the end of growth stage in most of the treatments in comparison to earlier stages was probably due to the weak effects of the treatments leading to the killing of more number of leaves. Selvaraja et al (2014) have also conducted experiments with the use of *P fluorescens* where they could obtain significant increase in number of leaves confirming the findings of the present experiment. However in some of the treatments like $T_1$, $T_4$, $T_7$, $T_9$ and $T_{10}$ there was decrease in the number of leaves as the plants advanced from 210 to 270 DAP. This could be due to the fact that at later stages the disease had already set in the plants leading to more number of leaves being affected by wilt disease and killed.

**Total leaf area:** Total leaf area is an important attribute contributing to the yield. The difference in total leaf area among the treatments was significant at all the stages of observation. At the final stage of plant growth it ranged from 2.47 $m^2$ in $T_{10}$ (control) to 4.61 $m^2$ in $T_6$ (sucker treatment and soil drenching with biocontrol agents). Invariably the $T_{10}$ recorded the minimum and $T_6$ the maximum significant total leaf area at all the days of observations. $T_8$ (soil application of biocontrol agents) was at par with $T_6$ in producing larger leaf area. This beneficial effect of the biocontrol agents in suppressing wilt disease and increasing leaf area has also been reported by Akila et al (2011).

### Disease characters (Table 2)

**Yellow leaves in a plant:** The data reveal significant differences among all the treatments. $T_6$ with sucker treatment and soil drenching twice by *T viride* and *P fluorescens*

Table 1. Effect of different treatments on plant height, plant girth, number of leaves and total leaf area at different growth stages

| Treatment | Plant height (cm) | Plant girth (cm) | # leaves at DAP | | | | Total leaf area ($m^2$) at DAP | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | at 270 DAP | at 270 DAP | 90 | 150 | 210 | 270 | 90 | 150 | 210 | 270 |
| $T_1$ | 120.33 | 38.50 | 7.73 | 8.20 | 10.20 | 10.00 | 1.38 | 1.76 | 3.54 | 3.47 |
| $T_2$ | 141.17 | 41.67 | 7.80 | 8.33 | 11.17 | 11.27 | 1.54 | 1.78 | 3.83 | 3.60 |
| $T_3$ | 137.93 | 41.17 | 7.07 | 7.67 | 10.20 | 10.47 | 1.45 | 1.50 | 3.40 | 3.37 |
| $T_4$ | 135.17 | 41.33 | 7.40 | 8.13 | 10.70 | 10.33 | 1.48 | 1.73 | 2.78 | 2.57 |
| $T_5$ | 121.83 | 37.67 | 7.33 | 7.67 | 10.10 | 10.53 | 1.34 | 1.36 | 3.03 | 2.93 |
| $T_6$ | 147.40 | 45.67 | 8.40 | 9.13 | 11.53 | 11.67 | 1.59 | 2.16 | 4.57 | 4.61 |
| $T_7$ | 133.50 | 36.83 | 7.13 | 7.67 | 10.70 | 10.20 | 1.32 | 1.72 | 3.59 | 3.33 |
| $T_8$ | 143.83 | 44.17 | 8.37 | 8.67 | 11.20 | 11.47 | 1.56 | 1.90 | 4.43 | 4.30 |
| $T_9$ | 129.17 | 37.50 | 7.73 | 7.13 | 11.13 | 9.73 | 1.51 | 1.77 | 3.33 | 3.27 |
| $T_{10}$ | 106.17 | 35.17 | 7.63 | 6.67 | 8.53 | 8.27 | 1.27 | 1.59 | 2.54 | 2.47 |
| SEm± | 6.540 | 1.839 | 0.322 | 0.446 | 0.526 | 0.562 | 0.092 | 0.117 | 0.276 | 0.232 |
| $CD_{0.05}$ | 19.430 | 5.464 | NS | 1.326 | 1.564 | 1.669 | 0.272 | 0.347 | 0.821 | 0.690 |

Data in parentheses indicate angular transformed values

Table 2. Effect of different treatments on number of yellow leaves, dead leaves, days taken to shooting and bunch yield of banana

| Treatment | Yellow leaves (%)/plant (360 DAP) | Dead leaves (%)/plant (360 DAP) | Days taken to shooting | Bunch yield (kg/plant) |
|---|---|---|---|---|
| $T_1$ | 24.30 (32.34) | 44.50 (41.70) | 276.8 | 5.26 |
| $T_2$ | 27.20 (31.39) | 38.60 (38.34) | 267.2 | 8.71 |
| $T_3$ | 29.60 (32.85) | 49.00 (44.40) | 274.0 | 7.13 |
| $T_4$ | 27.90 (31.88) | 52.60 (46.50) | 276.1 | 6.08 |
| $T_5$ | 28.90 (32.38) | 44.40 (41.78) | 275.1 | 7.55 |
| $T_6$ | 23.50 (28.85) | 31.00 (33.77) | 261.9 | 10.31 |
| $T_7$ | 28.60 (32.30) | 56.10 (48.53) | 274.3 | 6.99 |
| $T_8$ | 26 .20 (29.91) | 35.90 (36.78) | 264.1 | 9.01 |
| $T_9$ | 27.50 (31.61) | 44.70 (44.74) | 280.2 | 7.99 |
| $T_{10}$ | 38.10 (37.91) | 58.10 (49.65) | 284.3 | 3.86 |
| SEm± | 2.426 | 2.583 | 3.77 | 0.505 |
| $CD_{0.05}$ | 7.207 | 7.673 | 11.19 | 1.502 |

Data in parentheses indicate angular transformed values

resulted in lowest per cent of yellow leaves (23.50) whereas $T_{10}$ the control exhibited the highest value (38.10).

**Dead leaves in a plant:** Similar to the occurrence of yellow leaves $T_6$ resulted in significantly lowest per cent (31.00) of dead leaves caused by Fusarium wilt whereas $T_{10}$ showed the highest value (58.10). $T_8$ with soil application of the biocontrol agents was at par with $T_6$ in production of dead leaves. Treatments like $T_4$ and $T_7$ were not effective as they were at par with $T_{10}$. Dowling and O'Gara (1994) also obtained similar results where they could obtain antifungal metabolites from *P fluorescens* which caused inhibition of fungal cell multiplication of the pathogenic fungi.

**Yield related characters (Table 2)**

**Days taken to shooting:** Bunch emergence was observed the earliest (262 DAP) in $T_6$ and latest (280 DAP) in $T_{10}$. The only treatment to remain at par with $T_6$ in showing early flowering was $T_8$ (264 DAP). This clearly demonstrated that days taken to flower emergence were directly correlated with the intensity of wilt disease. The plants in the control plot required longest time (284 days) for flowering as they were very low in vitality and vigour.

**Bunch yield:** The bunch yield was found to be highly variable among the treatments. $T_6$ resulted in significantly the highest bunch yield (10.3 kg/plant) while $T_8$ produced at

par yield (9.01 kg/plant). $T_{10}$ exhibited significantly lowest yield (3.86 kg/plant). The use of neem cake though not very effective in controlling the disease was a significantly superior treatment over the control in producing good bunch yield which probably controlled the rhizome weevil attack and thereby subsequently reduced the secondary infection by wilt pathogen. Similar results have been reported by Karthikeyan and Karunanithi (1996).

## CONCLUSION

Sucker treatment and soil drenching with biocontrol agents *T viride* and *P fluorescens* increased pseudostem height and girth, number of leaves and total leaf area. It also resulted in lower incidence of Fusarium wilt as indicated by number of yellow and dead leaves and thereby produced highest bunch yield in earliest period of time in culinary banana, *Musa* sp cv Bantal.

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